

# **JITC ADS Efforts in Support of T&E and Interoperability Testing**

*ABSTRACT: The Joint Interoperability Test Command (JITC) has developed advanced distributed simulation (ADS) capabilities to simulate an operationally realistic battlespace environment and emulate electromagnetic signal feeds and communications traffic correlated with the simulated operational environment. These capabilities are used in support of JITC's mission of performing operational and interoperability testing of Command, Control, Communications, Computers, and Intelligence (C4I) systems. JITC has two projects in development which have the potential to significantly upgrade its capability to conduct joint interoperability of C4I systems, and to link ADS with test ranges.*

*Maxwell Chi*

Joint Interoperability Test Command

ATTN: JTF

Ft. Huachuca, AZ 85613-7020

e-mail:chim@fhu.disa.mil

voice: 520-538-5514

fax 520-538-5003

*Kenneth Thomas*

Joint Interoperability Test Command

ATTN: JTBB

Ft. Huachuca, AZ 85613-7020

e-mail:thomask@fhu.disa.mil

voice: 520-538-5170

fax 520-538-0371

*Mark Swift*

Joint Interoperability Test Command

ATTN: JTB

Ft. Huachuca, AZ 85613-7020

e-mail:swiftm@fhu.disa.mil

voice: 520-538-5057

fax 520-538-0371

## **1. Introduction**

The Joint Interoperability Test Command (JITC) has three main missions: it is the operational test agency (OTA) for Defense Information Systems Agency (DISA) C4I programs; it is the single DOD authority for certifying joint interoperability of C4I systems; and it provides technical assistance to the warfighter on C4I systems. JITC frequently conducts testing on networks of systems, including the Joint Data Network (JDN) and Joint Planning Network (JPN). Examples of links are the Tactical Information Broadcast System (TIBS), Tactical Digital Information Link (TADIL) and the Joint Variable Message Format (JVMF). Examples of systems that reside on the JDN are the Patriot, and Airborne Warning and Control System (AWACS). The JPN is primarily an Internet protocol (IP) network of classified and unclassified subnetworks connecting C2 and intelligence systems. For example the Secret Internet Protocol Routing Network (SIPRNet) is a classified subnetwork of the Defense Information System Network (DISN). The Global

Command and Control System (GCCS), and Defense Message System (DMS) are examples of systems residing on the JPN. GCCS is the current DOD Command and Control System of Record and is deployed at over 600 sites worldwide. DMS is a global messaging system that provides secure worldwide connectivity between warfighters operating from multiple platforms. JITC applies advanced distributed simulation (ADS) technology to the test and evaluation (T&E) and interoperability certification processes of systems on the JDN and JPN in order to improve product quality and function, reduce technical risk, enhance performance assessments, and make comprehensive T&E more affordable. The JITC also performs operational and developmental testing for the GCCS and DMS in consonance with the evolutionary acquisition strategy that is being implemented by the respective DISA program managers. JITC conducts multiple operational and interoperability tests for these systems as new evolutionary versions are released.

## **2. JITC projects**

## 2.1 Experiences Using ADS in Support of Interoperability Testing

The Joint Interoperability Evaluation System (JIES) supports interoperability certification testing of tactical C4I systems. JIES became operational and has been used by JITC in interoperability tests since 1993, replacing an earlier but similar capability. JIES is an evaluation tool at JITC and is part of a distributed network of models and live laboratory hardware in the loop (HWIL) systems that supports interoperability testing and training, as shown in Figure 1.

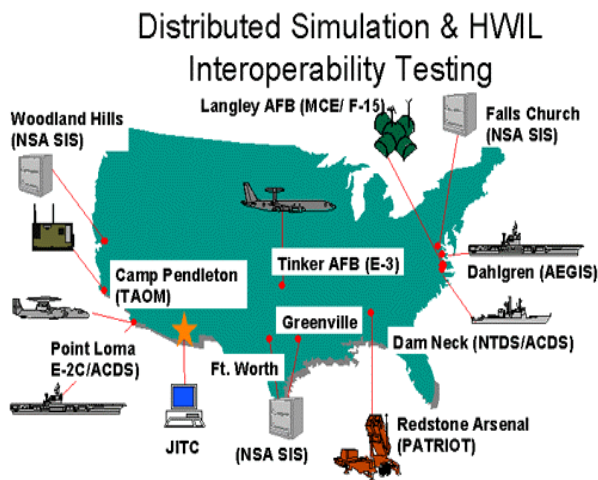


Figure 1. JTDLL and Hardware-in-the-Loop (HWIL) Network Nodes

This network is known as the Joint Tactical Data Link Laboratory (JTDLL). JIES includes an integral motion simulation or can be driven by an external battlespace simulation such as the Joint Interim Mission Model (JIMM), located at the CTF in Ft Huachuca, Arizona. JIES currently sends distributed interactive simulation (DIS) protocol data units (PDUs) to the remote test facilities where the laboratory tactical systems are located. The DIS PDUs representing battlespace objects are detected by sensor simulations and translated to emulated sensor signals which are sent to the tactical systems. The systems process the inputs and generate messages on the JDN that are monitored, recorded and analyzed by the JIES.

Tests using JIES have found numerous interoperability problems such as tactical unit reporting responsibility issues, data link problems, individual C4I deficiencies, and position/location anomalies. Much of the information is classified, but is available through JITC via the SIPRNet. A major observation resulting from these experiences is that many DOD networks and tools for interoperability testing, such as the Theater Missile Defense System Exerciser (TMDSE) and Navy Distributed Engineering

Plant (DEP), have been developed independently and are not interoperable. The Joint C4ISR Test and Evaluation Capability (JCTEC) is a new JITC/Navy initiative to link ADS systems as well as open air test ranges with a standard interface, and establish some standard testing and business procedures with intentions to resolve these deficiencies. JITC is currently developing a High-Level Architecture (HLA)-compliant sensor simulation capability. This capability is illustrated in Figure 2.

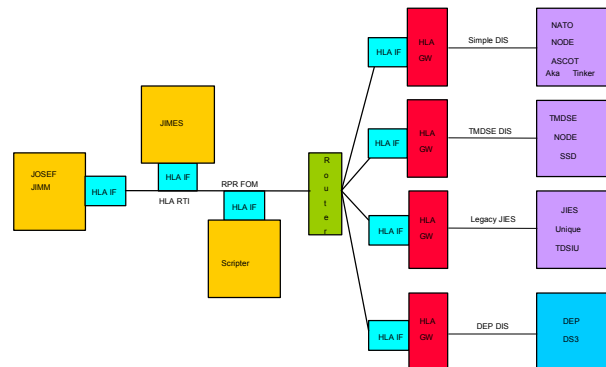


Figure 2. JOSEF/JIMES Sensor Sim Relationship

The use of HLA-compliant gateways can expand the current sensor simulation capability to other existing and proposed networks. This will provide limited interoperability and serve as a temporary transition step to the JCTEC, which is described in the next section.

The Joint Interoperability Modular Evaluation System (JIMES) is a modernization of JIES designed to ensure it can evaluate the interoperability of C4I systems well into the twenty-first century. JIMES will replace the existing FORTRAN and VAX-based JIES engines with state-of-the-art monitor engines hosted on inexpensive and flexible Windows NT platforms, as well as transition to a Defense Information Infrastructure (DII)/Common Operating Environment (COE)-supported platform environment.

The JIMES will receive tactical messages, convert those messages into human-readable format, and display them to the user. It will also parse the information and insert it into a central track database. JIMES will require the track database to provide a real-time situation display to the user. It will also allow the user to highlight specific tracks and request more detailed data.

To support its third main mission, technical assistance to the warfighter, JITC regularly attends operational exercises to collect data on C4I systems performance. A lesson learned from this experience is that results from laboratory testing and those from live field exercises are not always correlated. One frequent cause of this discrepancy is lack of configuration control, with the result that the fielded

systems are often different versions from those that were tested in the laboratory. Additionally, information is not always shared between the lab and field exercise communities, so that new systems often appear in the field that lab testers were not aware of. An example of the last two points is the Air Defense Systems Integrator (ADSI), which has over 70 mutually non-interoperable versions. Still another observation is that current test networks are not adapted to the current revolution in warfare, with its emphasis on joint, network-centric warfare and multiple C4I systems' interoperability. The JCTEC is a new initiative which includes solutions to these lessons learned to link ADS systems and open air test ranges, and will be intended to resolve these deficiencies.

## 2.2 Linking of ADS Systems and Test Ranges

JCTEC is an approved new start in FY01 under the OSD Central Test and Evaluation Investment Program (CTEIP), to be developed by JITC in partnership with the Naval Air Warfare Center. JCTEC will combine laboratories, test networks, and open air ranges to create a joint battlespace environment for the conduct of interoperability testing and experimentation.

The JCTEC project will consist of the following major parts:

### (1) JCTEC Joint Test Federation

A HLA federation of laboratories, test facilities and open air ranges which will provide the models, simulations and stimulators to test and evaluate systems-of-systems in an overall synthetic joint battlespace.

### (2) C4ISR Distributed Test Network

This will simulate, stimulate, inject and retrieve data from the primary C4ISR Networks into and from the test environment.

### (3) JCTEC Test Op Center Software Suite

An integrated suite of software applications will provide tools for the planning, execution, analysis and reporting of C4ISR Interoperability Testing and Experimentation.

### (4) C4ISR Mobile Integrated Instrumentation System (CMIS)

CMIS shall be an integrated/modularized instrumentation suite designed to capture all data required to facilitate C4ISR Testing and Certification.

Figure 3 illustrates the JCTEC concept of operations.

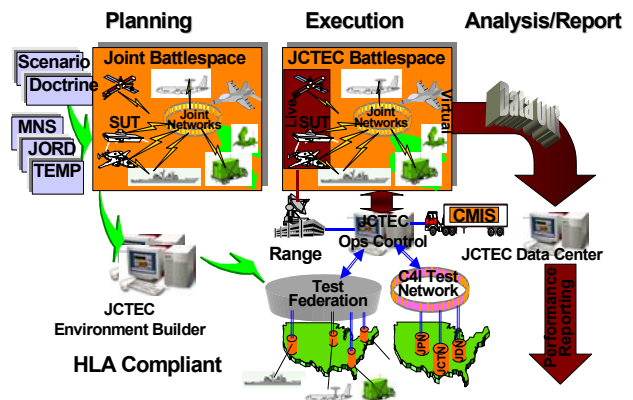


Figure 3. JCTEC Concept of Operations

## 2.3 ADS Support of T&E

To support its operational test and evaluation (OT&E) mission, JITC developed the Joint OT&E Simulation Environment Facility (JOSEF). The JOSEF has been used regularly in both OT&Es and interoperability tests of the GCCS and DMS. JOSEF creates a number of multiple correlated tactical and intelligence message feeds in order to address the systems' performance in realistic stress conditions in a controlled, repeatable test.

Although used primarily for T&E of systems residing on the JPN, JOSEF is also used to test interoperability between the JDN and JPN, in that it can test interoperability between GCCS on the JPN and its interfaces such as TADIL and TIBS on the JDN. GCCS operation requires interoperability between the JDN and JPN. Sensor warnings are sent to a GCCS node by systems on the JDN, such as AEGIS and AWACS, and are disseminated via SIPRNet and DMS to other nodes and systems on the JPN, such as the Theater Battle Management Core Systems (TBMCS) or GCCS-M (Maritime).

JOSEF is intended to meet these objectives:

- Simulate an operationally realistic battlespace environment
- Emulate communications traffic correlated with the simulated operational environment
- Stimulate live systems in operational test networks with emulated communications traffic
- Collect and analyze C4I network traffic and provide data for calibration and validation of constructive models

- Use validated constructive models to supplement live operational testing data
- Use HLA standards and HLA Run-time Infrastructure-interoperable (RTI-interoperable) components
- Support teaming with other test agencies.

Figure 4 depicts the JOSEF test architecture framework.

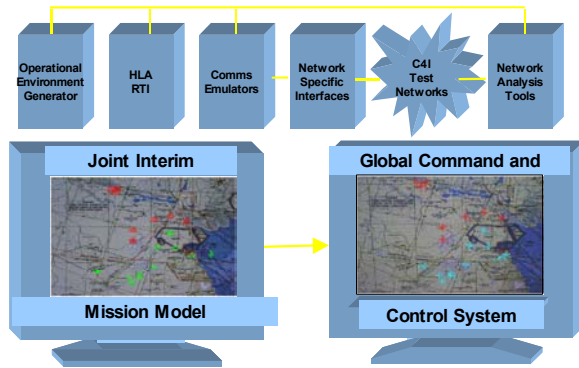


Figure 4. JOSEF Architecture

### 2.3.1 GCCS testing with JOSEF

GCCS operational testing requires testers to:

- Assess Performance and Interoperability critical operational issues (COIs) in a representative battlespace.
- Assess the ability of the GCCS Common Operational Picture (COP) to correlate information from multiple sources. GCCS supports situational awareness by merging information from multiple tactical sources to produce a near-real-time situation display known as the COP. The COP receives information over multiple communication channels from other intelligence and command and control systems. For example, missile launch warnings come via the JDN. This requires stimulation of the COP with realistic tactical message feeds that are:
  - Known in advance. This supports development of an “expected result” and facilitates comparison of actual results to expected results for test purposes.
  - Repeatable. This facilitates comparison of results from multiple test cases (for example, before and after a software update).
  - Realistic in content and volume.
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Figure 5 shows the GCCS test architecture.

JOSEF uses the JIMM, which complies with HLA standards and which was developed by the Joint Strike

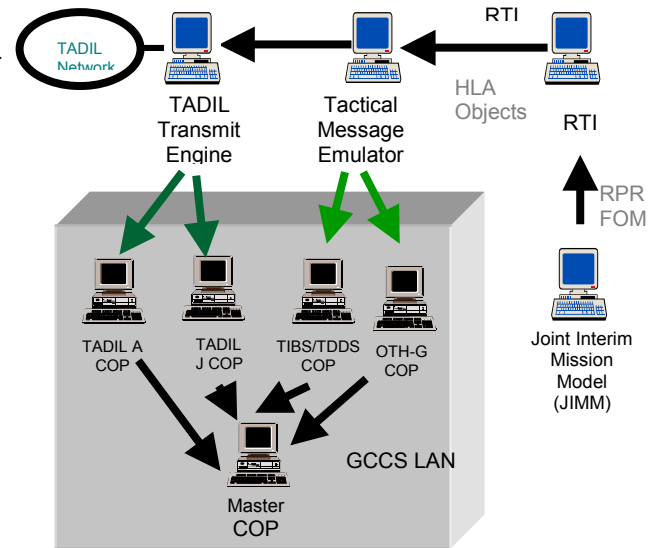


Figure 5. GCCS Test

Fighter Program Management Office. JIMM is a HLA-compliant, object-oriented, general-purpose conflict simulation. JIMM can participate in a network with other simulations, hardware, and man-in-the-loop systems, or run in a stand-alone constructive manner. Multiple-sided conflicts involving air, ground, naval, and space forces may be simulated. JIMM represents the mental aspects of organizational structures, responsibilities, tactics, contingency plans, attitudes, perceptions, memory, and motivations. It also represents the physical aspects of the environment, communications, information gathering and exchanging, physical influence, disruption, and movement. Players consist of platforms, elements, systems, and expendables that can move, shoot, talk, sense, disrupt, and think. The JOSEF JIMM provides state information about battlespace objects via the Real-time Platform Reference (RPR) Federated Object Model (FOM). The RTI communicates this information to the Tactical Message Emulator (TME). The TME in turn uses this information to produce required messages to stimulate GCCS. JOSEF allows JITC to overcome recognized operational test shortfalls. It supports robust GCCS testing in a representative battlespace, with multiple correlated feeds under realistic stress conditions.

There is an additional link between the JTDLL, described previously, and the JOSEF, such that JOSEF can stimulate the remote HWIL systems of the JTDLL, which can then provide live TADIL messages that can be used to stimulate the GCCS JDN interfaces.

### 2.3.2 DMS testing with JOSEF

JOSEF supports DMS testing in two key areas: stress testing and network performance analysis. Figure 6 shows the overall DMS test architecture.

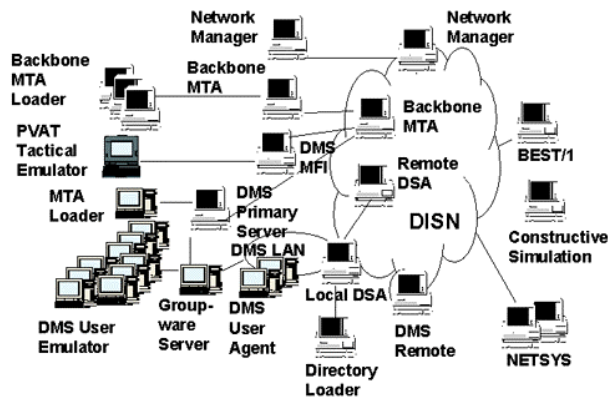


Figure 6. DMS Test Architecture

JOSEF includes several devices that induce loads on specific DMS components and support evaluation of COIs. Specifically, these components allow JITC to determine the effect of variable loads on system performance and to determine breakpoints. The DMS stress testing capabilities are described in the following paragraphs.

The DMS User Emulator, an adaptation of a commercial-off-the-shelf (COTS) remote terminal emulator (RTE), represents the load on DMS User Agents (UAs) associated with up to 512 individual users and workstations at potentially two different organizational elements. The emulator software simulates message traffic by repeating the keystrokes of sample messages in a scripted fashion. It also captures performance data for calibrating and validating DMS models.

The Message Transfer Agent Loader (MTAL), a JITC-developed device, provides traffic loading associated with up to 50,000 users on DMS local and backbone Message Transfer Agents (MTAs). The MTA is a key routing component in the DMS architecture. The MTAL is a transportable capability that can be physically located at remote DMS operational test sites as needed.

Directory Services Loaders emulate directory access actions of up to 50,000 users. This level of loading is critical for realistic testing of DMS Directory Service Agents (DSAs).

Figure 6 also shows two commercial packages, BEST/1 and NETSYS, that are included in JOSEF's network analysis capabilities. BEST/1 uses a queuing-theory-based model to support evaluation of alternative configurations, bottlenecks, and "what-if" questions. NETSYS supports analysis of network design, visualization of network connections, and troubleshooting of router configuration problems.

The distributed DMS testbed is composed of three remote sites and the JOSEF DMS loading capabilities can be used to provide background traffic for all sites during testing. However, much of the performance information is actually gathered in a local stand-alone configuration and used as information for operational tests and operational evaluations.

### 3. Summary

JITC has over eight years' experience in using its ADS capabilities to support its missions of interoperability testing and T&E of C4I systems. The lessons learned from that experience have led JITC and the Navy to begin development of a new capability to link ADS and open-air test ranges to fulfill new requirements for C4I T&E resulting from the current increased emphasis on network centric warfare and multiple systems interoperability.

### Author Biographies

**MAXWELL CHI** holds a Master's degree in Information Systems from the Naval Postgraduate School. He is currently a project analyst for the JOSEF.

**KENNETH THOMAS** received his Bachelor of Science in Engineering Mathematics from the University of Arizona and graduate certificate in information systems engineering from George Mason University. He is currently the project leader and principal architect for the JOSEF, as well as a principal author of the JCTEC proposal. He has over 25 years of professional experience and is a member of IEEE Computer Society and ITEA.

**MARK SWIFT** received his Masters degree with a major in M.I.S. from New Mexico Highlands University. He is currently the program manager for the Joint Operational C4I Assessment Team JOCAT and the Joint Interoperability Modular Evaluation System JIMES. Mr. Swift has 13 years of professional experience with the federal government.